THE CAUSES FOR GEOGRAPHICAL VARIATIONS IN $^{187}OS/^{186}OS$ AT THE CRETACEOUS-TERTIARY BOUNDARY;

K.K. Turekian, B. K. Esser, G. E. Ravizza, Department of Geology and Geophysics, Yale University, Box 6666, New Haven, CT 06511

Luck and Turekian's (1983) study of the iridium-rich layers at the Cretaceous-Tertiary boundary established that the $^{187}Os/^{186}Os$ ratios of these layers are about 1, in keeping with a meteoritic (or mantle) imprint. They noted subtle variations in the $^{187}Os/^{186}Os$ ratios of different boundary layers: 1.65 in the marine section at Stevns Klint and 1.29 in the continental section in the Raton basin. Although these variations could be explained as the result of the impact of different bolides with different Re/Os ratios, this is not the most conservative explanation. Luck and Turekian ended their 1983 paper by saying that if the differences were not of cosmic origin "...there have been different amounts of crustal osmium contamination, by unspecified processes." Simple dilution by crustal debris during impact could be excluded by mass balance calculations based on the putative size of the projectile (if meteoritic).

Recently our group at Yale has approached the problem of the osmium isotopic composition of marine deposits formed in contact with both oxidized and reduced bottom waters (2,3,4). The measured $^{187}Os/^{186}Os$ ratios of modern bulk sediment can be explained using mixing equations involving continental detrital, volcaniclastic, cosmogenic and hydrogenous components. These studies show that sediments deposited under reducing marine conditions contain a hydrogenous component which is enriched in Re and has a radiogenic $^{187}Os/^{186}Os$ ratio. The presence of such a hydrogenous component in the marine fish clay at Stevns Klint can account for the elevation of its $^{187}Os/^{186}Os$ ratio above the expected meteoritic value (1,5). Mass balance considerations require the Re/Os ratio of the phase precipitated from the terminal Cretaceous sea at Stevns Klint to have been about one tenth the value observed in contemporary deposits in the Black Sea, assuming Re has not been lost (or Os gained) subsequent to precipitation. In continental sections, the elevation of the $^{187}Os/^{186}Os$ ratio in boundary layers may be due to precipitation from continental waters of crustally-derived radiogenic osmium either contemporaneous with the meteoritic (or mantle) osmium deposition or later during diagenesis. Such a mechanism has been demonstrated by Esser and Turekian (6) for a freshwater manganese nodule from Oneida Lake (N.Y.). The nodule contains predominantly hydrogenous osmium with an $^{187}Os/^{186}Os$ ratio of 17.

Since ^{187}Os enriched precipitates can increase the $^{187}Os/^{186}Os$ ratio of boundary layers relative to the primary meteorite value in both marine and nonmarine environments, there is no reason to propose more than one impact (or mantle-related) event on the basis of the slight variability of $^{187}Os/^{186}Os$ ratio observed in Cretaceous-Tertiary boundary layers.

References:

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